METHYL BROMIDE CRITICAL USE RENOMINATION FOR POST-HARVEST USE TREATMENT BY NATIONAL PEST MANAGEMENT ASSOCIATION

EXECUTIVE SUMMARY

This nomination is for facilities, or portions of facilities, that are unsuitable for methyl bromide alternatives, and where the alternatives are not economically feasible. Sulfuryl fluoride is highly dependent upon temperature, so should a facility need fumigation during cooler temperatures, it may not be the product of choice because of increased costs. Also sulfuryl fluoride requires higher dosages for egg kill, and in many facilities killing eggs is paramount; this also may lead to higher costs. Phosphine is corrosive to many metals that are present in facilities, especially in the computers; and is flammable. Heat is dependent on the structural composition, as different components expand and contract at different rates. Cheese does not have a technically and economically feasible alternative to methyl bromide at this time.

METHYL BROMIDE CRITICAL USE RENOMINATION NOMINATION FOR STRUCTURES, COMMODITIES OR OBJECTS

NOMINATING PARTY:
The United States of America

NAME
USA CUN10 **POST HARVEST** **NATIONAL PEST MANAGEMENT ASSOCIATION (NPMA)**

BRIEF DESCRIPTIVE TITLE OF NOMINATION:
Methyl Bromide Critical Use Nomination for Post Harvest Use by NPMA (Submitted in 2008 for 2010 Use Season)

STRUCTURE, COMMODITY OR OBJECT TREATED:
This sector includes commodities and food processing plants treated by National Pest Management Association (NPMA) members and are not included in the Commodity or in the Food Facilities Chapters of the US nomination. This application includes: processed foods (such as chips, crackers, cookies and pasta), spices and herbs, and cheese processing plants. Methyl bromide is typically utilized in processed food and feed facilities as a space fumigant for treating the facility 1 to 3 times per year. As the need arises, methyl bromide is also used for trailer fumigations of product or packaging material. These facilities are under intense pressure from many insect pests as well as rodents.

CHEESE: Methyl bromide fumigation for cheese occurs to ensure pest-free food and meet the strict requirements of the Food Sanitation Regulations. Cheese manufacturers may target their products during fumigations with methyl bromide when a mite infestation is identified by USDA inspection and a fumigation is ordered. Cheese does not have a technically and economically feasible alternative available. Whereas sulfuryl fluoride and phosphine are the primary alternatives in most commodities, they are unsuitable for cheese facilities. Phosphine fumigations take much longer than methyl bromide fumigations and are not a feasible alternative when rapid fumigations are needed; is corrosive to certain metals; is limited by temperature, and is not effective on mites. Sulfuryl fluoride is under investigation to determine its efficacy on mites, especially in the low temperature environment of cheese facilities. It is unknown at this time what amounts of sulfuryl fluoride will be able to replace methyl bromide in this sector. Also, adoption of not in kind alternatives, such as controlled atmospheres, cold, and carbon dioxide under pressure, would require major investments for appropriate treatment units and/or retrofitting of existing cheese manufacturing facilities.

FACILITIES: Primarily this sector is treating only the portions of the facilities that contain electronic components and have machinery with copper and copper alloy parts. These facilities are under intense pressure from many insect pests. The majority of these food processors do not target any of their commodities to be fumigated with methyl bromide, although some ingredients may be present in the equipment during fumigation, or the ingredients and products may be separable from the processing portion of the facilities.

Food processing facilities in the United States have reduced the number of methyl bromide fumigations by incorporating many different techniques to control pests. The most critical strategy implemented is IPM, especially sanitation, in all areas of a facility. Facilities are now being monitored for pest populations, using visual inspections, pheromone traps, light traps and electrocution traps. When insect pests are found, facilities will attempt to contain the infestation with treatments of low volatility pesticides applied to both surfaces and cracks and crevices; spot treatments with heat or phosphine will be used in areas that are suitable. Incoming ingredients are inspected for insect pests and may be treated with phosphine. These techniques do not disinfest a facility but are critical in monitoring and managing pests, and hopefully preventing outbreaks. However, when all these methods fail to control a pest problem, facilities must rely on fumigation, to kill insects within the equipment and even the walls of the structure. There are two primary fumigants available to this industry: methyl bromide and sulfuryl fluoride.

Herbs and Spices
Methyl bromide is requested for a few small mills where herbs and spices are blended into packages (such as for pizza mixes) that are then added to pre-packaged goods. These facilities are similar to food processing facilities in that there are silos, mixing areas, packaging areas, etc. These facilities utilize methyl bromide to target pests present in inaccessible areas of the structure, such as the equipment and buildings. The ingredients or finished products that may be stored on-site are not targeted for fumigation. However, the problem in some of these small mills is that they are all under one roof without any way to completely segregate the different areas. In addition, since these are small companies they have economic constraints.

Fumigants of choice for treating herb and spice commodities are ETO, PPO, irradiation and phosphine. These alternatives are not feasible to disinfect the facility itself.

This nomination is for facilities, or portions of facilities, that are unsuitable for the alternatives, and where the alternatives are not economically feasible. Sulfuryl fluoride is highly dependent upon temperature, so should a facility need fumigation during cooler temperatures, it may not be the product of choice. Also sulfuryl fluoride requires higher dosages for egg kill, and in many facilities killing eggs is paramount. Phosphine is corrosive to many metals that are present in facilities, especially in the computers; and it is explosive. Heat is dependent on the structural composition, as different components expand and contract at different rates.

QUANTITY OF METHYL BROMIDE REQUESTED IN EACH YEAR OF NOMINATION:

TABLE COVER SHEET: QUANTITY OF METHYL BROMIDE REQUESTED IN EACH YEAR OF NOMINATION

YEAR	NOMINATION AMOUNT (KILOGRAMS)
2010	**37,778**

SUMMARY OF ANY SIGNIFICANT CHANGES SINCE SUBMISSION OF PREVIOUS NOMINATIONS:

There is a major change to this 2010 nomination from NPMA. An economic study found that sulfuryl fluoride is economically feasible for cocoa beans (Adam 2007). Therefore NPMA has not requested methyl bromide for use on cocoa beans for 2010, and is hoping to have all the cocoa beans transitioned to sulfuryl fluoride by 2009. Sulfuryl fluoride is not always economically feasible in all food processing facilities (Adam 2007), therefore that portion of NPMA's request remains.

NOMINATING PARTY CONTACT DETAILS:

Contact Person:	Hodayah Finman
Title:	Foreign Affairs Officer
Address:	Office of Environmental Policy U.S. Department of State 2201 C Street, N.W. Room 2658 Washington, D.C. 20520 U.S.A.
Telephone:	(202) 647-1123
Fax:	(202) 647-5947
E-mail:	finmanhh@state.gov

Following the requirements of Decision IX/6 paragraph (a)(1) [*insert name of Party*] has determined that the specific use detailed in this Critical Use Nomination is critical because the lack of availability of methyl bromide for this use would result in a significant market disruption. X Yes ☐ No

____________________________ ______________________________ _______________

Signature Name Date

Title: ____

CONTACT OR EXPERT(S) FOR FURTHER TECHNICAL DETAILS:

Contact/Expert Person:	Richard Keigwin
Title:	Division Director
Address:	Biological and Economic Analysis Division Office of Pesticide Programs U.S. Environmental Protection Agency 1200 Pennsylvania Avenue, N.W. Mailcode 7503P Washington, D.C. 20460 U.S.A.
Telephone:	(703) 308-8200
Fax:	(703) 308-7042
E-mail:	Keigwin.Richard@epa.gov

LIST OF DOCUMENTS SENT TO THE OZONE SECRETARIAT IN OFFICIAL NOMINATION PACKAGE:

1. PAPER DOCUMENTS: **Title of paper documents and appendices**	**No. of pages**	**Date sent to Ozone Secretariat**
USA CUN10 Post Harvest National Pest Management Association		
2. ELECTRONIC COPIES OF ALL PAPER DOCUMENTS: ***Title of each electronic file (for naming convention see notes above)**	**No. of kilobytes**	**Date sent to Ozone Secretariat**
USA CUN10 Post Harvest National Pest Management Association		

TABLE OF CONTENTS

TABLE OF TABLES

PART A: SUMMARY INFORMATION

1. NOMINATING PARTY AND NAME:

The United States of America
USA CUN10 POST HARVEST NATIONAL PEST MANAGEMENT ASSOCIATION (NPMA)

2. DESCRIPTIVE TITLE OF NOMINATION:

Methyl Bromide Critical Use Nomination for Post Harvest Use by NPMA (Submitted in 2008 for 2010 Use Season)

3. YEAR FOR WHICH EXEMPTION SOUGHT: 2010

TABLE A 1. QUANTITY OF METHYL BROMIDE REQUESTED IN EACH YEAR OF NOMINATION

YEAR	NOMINATION AMOUNT (KILOGRAMS)
2010	37,778

4. SUMMARY OF ANY SIGNIFICANT CHANGES SINCE SUBMISSION OF PREVIOUS NOMINATIONS (*e.g. changes to requested exemption quantities, successful trialling or commercialisation of alternatives, etc.*)

There is a major change to this 2010 nomination from NPMA. An economic study found that sulfuryl fluoride is economically feasible for cocoa beans (Adam 2007). Therefore NPMA has not requested methyl bromide for use on cocoa beans for 2010, and is hoping to have all the cocoa beans transitioned to sulfuryl fluoride by 2009. Sulfuryl fluoride is not always economically feasible in all food processing facilities (Adam 2007), therefore that portion of NPMA's request remains.

The remaining portions of this sector include cheese and food processing plants treated by National Pest Management Association (NPMA) members and are not included in the Commodity or in the Food Facilities Chapters of the US nomination. Food Processing Facilities included in this application are: processed foods (such as chips, crackers, cookies and pasta), spices and herbs, and cheese processing plants. Methyl bromide is typically utilized in processed food and feed facilities as a space fumigant for treating the facility 1 to 3 times per year. As the need arises, methyl bromide is also used for trailer fumigations of product or packaging material. These facilities are under intense pressure from many insect pests as well as rodents.

CHEESE: Methyl bromide fumigation for cheese occurs to ensure pest-free food and meet the strict requirements of the Food Sanitation Regulations. Cheese manufacturers may target their products during fumigations with methyl bromide when a mite infestation is identified by USDA inspection and a fumigation is ordered. Cheese does not have a technically and economically feasible alternative available. Whereas sulfuryl fluoride and phosphine are the primary alternatives in most commodities, they are unsuitable for cheese facilities. Phosphine fumigations take much longer than methyl bromide fumigations and are not a feasible alternative when rapid fumigations are needed; is corrosive to certain metals; is limited by temperature, and not effective on mites. Sulfuryl fluoride is under investigation to determine its efficacy on mites, especially in the low temperature environment of cheese facilities. It is unknown at this time what amounts of sulfuryl fluoride will be able to replace methyl bromide in this sector. Also, adoption of not in kind alternatives, such as controlled atmospheres, cold, and carbon dioxide under pressure, would require major investments for appropriate treatment units and /or retrofitting of existing cheese manufacturing facilities.

FACILITIES: Primarily this sector is treating only the portions of the facilities that contain electronic components and have machinery with copper and copper alloy parts. These facilities are under intense pressure from many insect pests. The majority of these food processors do not target any of their commodities to be fumigated with methyl bromide, although some may be present in the equipment during fumigation.

Food processing facilities in the United States have reduced the number of methyl bromide fumigations by incorporating many different techniques to control pests. The most critical strategy implemented is IPM, especially sanitation, in all areas of a facility. Facilities are now being monitored for pest populations, using visual inspections, pheromone traps, light traps and electrocution traps. When insect pests are found, facilities will attempt to contain the infestation with treatments of low volatility pesticides applied to both surfaces and cracks and crevices; spot treatments with heat or phosphine will be used in areas that are suitable. Incoming ingredients are inspected for insect pests and may be treated with phosphine. These techniques do not disinfest a facility but are critical in monitoring and managing pests, and hopefully preventing outbreaks. However, when all these methods fail to control a pest problem, facilities must rely on fumigation, to kill insects within the equipment and even the walls of the structure. There are two primary fumigants available to this industry: methyl bromide and sulfuryl fluoride.

Herbs and Spices
Methyl bromide is requested for a few small mills where herbs and spices are blended into packages (such as for pizza mixes) that are then added to pre-packaged goods. These facilities are similar to food processing facilities in that there are silos, mixing areas, packaging areas, etc. These facilities utilize methyl bromide to target pests present in inaccessible areas of the structure, such as the equipment and buildings. The ingredients or finished products that may be stored on-site are not targeted for fumigation. However, the problem in some of these small mills is that they are all under one roof without any way to completely segregate the different areas. In addition, since these are small companies they have economic constraints.

Fumigants of choice for treating herb and spice commodities are ETO, PPO, irradiation and phosphine. These alternatives are not feasible to disinfect the facility itself.

This nomination is for facilities, or portions of facilities, that are unsuitable for the alternatives, and where the alternatives are not economically feasible. Sulfuryl fluoride is highly dependent upon temperature, so should a facility need fumigation during cooler temperatures, it may not be the product of choice. Also sulfuryl fluoride requires higher dosages for egg kill, and in many facilities killing eggs is paramount. Phosphine is corrosive to many metals that are present in facilities, especially in the computers; and it is explosive. Heat is dependent on the structural composition, as different components expand and contract at different rates.

PART B: TRANSITION PLANS

Provision of a National Management Strategy for Phase-out of Methyl Bromide is a requirement under Decision Ex. I/4(3) for nominations after 2005. The time schedule for this Plan is different than for CUNs. Parties may wish to submit Section 21 separately to the nomination.

5. DESCRIBE MANAGEMENT STRATEGIES THAT ARE IN PLACE OR PROPOSED TO ELIMINATE THE USE OF METHYL BROMIDE FOR THE NOMINATED CRITICAL USE, INCLUDING:

1. Measures to avoid any increase in methyl bromide consumption except for unforeseen circumstances;
2. Measures to encourage the use of alternatives through the use of expedited procedures, where possible, to develop, register and deploy technically and economically feasible alternatives;
3. Provision of information on the potential market penetration of newly deployed alternatives and alternatives which may be used in the near future, to bring forward the time when it is estimated that methyl bromide consumption for the nominated use can be reduced and/or ultimately eliminated;
4. Promotion of the implementation of measures which ensure that any emissions of methyl bromide are minimised;
5. Actions to show how the management strategy will be implemented to promote the phase-out of uses of methyl bromide as soon as technically and economically feasible alternatives are available, in particular describing the steps which the Party is taking in regard to subparagraph (b) (iii) of paragraph 1 of Decision IX/6 in respect of research programmes in non-Article 5 Parties and the adoption of alternatives by Article 5 Parties.

The U.S. has submitted the National Strategy Management Plan in accordance with Decision IX/6

PART C: TRANSITION ACTIONS

Responses should be consistent with information set out in the applicant's previously-approved nominations regarding their transition plans, and provide an update of progress in the implementation of those plans.

In developing recommendations on exemption nominations submitted in 2003 and 2004, the Technology and Economic Assessment Panel in some cases recommended that a Party should explore the use of particular alternatives not identified in a nomination' transition plans. Where the Party has subsequently taken steps to explore use of those alternatives, information should also be provided in this section on those steps taken.

Questions 5 - 9 should be completed where applicable to the nomination. Where a question is not applicable to the nomination, write "N/A".

6. TRIALS OF ALTERNATIVES

Where available, attach copies of trial reports. Where possible, trials should be comparative, showing performance of alternative(s) against a methyl bromide-based standard

(i) DESCRIPTION AND IMPLEMENTATION STATUS:

Cocoa Beans

Adam (2007) conducted a cost comparison of methyl bromide and sulfuryl fluoride in the fumigation of cocoa beans. It is an economic-engineering approach, which estimates of costs that "typical" firms would face under different scenarios (Adam 2007). Adam (2007) found that with regards to cocoa beans, if the methyl bromide and sulfuryl fluoride are the same price per pound, then a sulfuryl fluoride fumigation is 1% less than a methyl bromide. Sulfuryl fluoride is more economical then methyl bromide for cocoa beans is primarily because less sulfuryl fluoride is needed (Adam 2007).

Cheese

There has been no research specific to cheese, as these facilities are only fumigated when mites are found during a USDA inspection. However, researchers investigating dry cured pork products are including cheese in their studies as the arthropod pests are the same, or at least very similar. For the convenience of MBTOC, the research information from the US nomination for dry cured pork products appears below.

In the spring of 2007 a proposal was submitted to USDA CSREES Integrated Research, Education, and Extension Competitive Grants Program- Methyl Bromide Transitions by several meat scientists and an entomologist. This proposal was recently funded for the next three years.

There are several objectives to this multiple year research program: First is to determine the effectiveness of chemical controls (sulfuryl fluoride, phosphine, and methyl bromide) against all life stages of both mold mites (*Tyrophagus putrescentiae*) and red legged ham beetles (*Necrobia rufipes*). Second objective is to determine the effectiveness of carbon dioxide and ozone against all life stages of both mold mites and red legged ham beetles. The third objective is to test the effects of sulfuryl fluoride, phosphine and methyl bromide on the quality and safety of the dry cured hams. The fourth objective is to conduct an economic analysis of the alternatives demonstrated to be technically viable alternatives for methyl bromide in this industry.

The research will be initially conducted under laboratory conditions. The treatments that are effective under laboratory settings will then be tested in industrial and commercial conditions. In addition to dry cured ham products, some of the biological studies will also be conducted on cheese, as the pests and conditions are the same.

To date there have been no efficacy studies to address the potential of alternatives, such as sulfuryl fluoride, to control critical pests under commercial conditions.

Facilities

Small (2007) compared fumigations of sulfuryl fluoride and methyl bromide in four UK flour mills. He used pheromone traps to monitor several stored product insect pests: rust red flour beetle, confused flour beetle, and Mediterranean flour moth. Traps were placed within each mill for 2 weeks prior to fumigation (except one mill the traps were placed in there just one week prior to fumigation). The post-fumigation populations were monitored with trap catch data at 2 weeks and 5 weeks. Each mill was fumigated twice, about a month apart. Small (2007) found that the efficacy of sulfuryl fluoride compared favourably to that of methyl bromide. Small (2007) did report that some populations were low pre-fumigation (i.e. confused flour beetle at Mill A); and that some influx of moths from outside the fumigated area was probably the source of elevated moths shortly after a fumigation. The dosage for sulfuryl fluoride ranged from 571 g h/m^3 to 1326 gh/m^3. The dosage for methyl bromide in the study ranged from231.5 gh/m^3 to 476.5 gh/m^3. The dosage rate of sulfuryl fluoride was 2 to 3 times the dosage rate of methyl bromide. Economics were not considered in this study.

Another study compared methyl bromide and sulfuryl fluoride fumigations in flour mills (Tsai, et al. 2006). Indianmeal moth and red flour beetle, all life stages were used in bioassays exposed during fumigations. In addition, before and after fumigation, insect monitoring by traps were conducted to determine pest populations and rebound rates. The preliminary results were 100% mortality of adults and larvae of both species for both fumigants. Sulfuryl fluoride had 100% mortality of pupae, whereas methyl bromide had 100% of Indianmeal moth pupae but only 99.6% of red flour beetle pupae at one facility. In reporting egg mortality, Tsai, et al. (2006) distinguished between two types: those eggs that do not hatch and those eggs that hatch but do not survive to adulthood. The methyl bromide fumigations had 100% egg mortality of red flour beetle eggs whereas sulfuryl fluoride in one facility had extremely high egg mortality, but in another facility the egg mortality was low. However, none of the hatched individuals matured to adults. Egg mortality of Indianmeal moth had different results. One facility fumigated with sulfuryl fluoride had 100% egg mortality, but the other facility had 99.67% egg mortality, but the hatched larvae all died before adulthood. One of the methyl bromide fumigated facilities also had 100% mortality of Indianmeal moth eggs, but the other facility 88.67% egg mortality and 95.4 % of the hatched larvae died before becoming adults. (Tsai, et al. 2006) This study does not report the fumigation parameters (although the information is available through Maier), nor does it have any economics included.

Dr. Maier's laboratory at Purdue University has been researching how fumigants move through structures. This agricultural engineering laboratory investigated how important such parameters as sealing, wind speed and direction, building temperature, fan circulation efficacy impact the effectiveness of fumigation (Maier, et al. 2007). For instance half life is a direct function of sealing. Improving half life could lead to a reduction in fumigant use. This research team has also demonstrated that temperatures in the mills are not constant, but are affected by weather conditions. (Maier, et al. 2007)

The final new study that compares methyl bromide structural fumigation to an alternative compares economics. This paper uses an economic-engineering approach to estimate costs that "typical" firms would incur under alternative scenarios, as opposed to specific firms and situations (Adam 2007). Adam (2007) compared methyl bromide to sulfuryl fluoride in a food processing facility. A number of parameters were considered including: labor costs, equipment costs, and fumigant costs. The results showed that although there are a number of costs that are essentially the same between methyl bromide and sulfuryl fluoride fumigations (labor rates, hours/worker, number of workers, worker training, etc.), there are several costs that are different. The interscan/electronic monitor and heavy-duty hoses, fittings are more expensive for sulfuryl fluoride than for methyl bromide (ca. \$6,000 vs. \$2,500, respectively), but spreading the costs over a year of 50 fumigations the difference is about \$23/job. The main difference in costs is the fumigant cost. This relates to the temperature and the level of control selected in the Fumiguide for sulfuryl fluoride. In a hypothetical fumigation of a 1,000,000 ft^3 facility, where a pound of either fumigant is \$7, the cost of sulfuryl fluoride (2.5 lb/1000 ft^3) was 90% higher than the cost of a 1 lb/1000 ft^3 dose of methyl bromide and 46% higher than the cost of a 1.5 lb/1000 ft^3 dose of methyl bromide. (Adam 2007)

USDA Agriculture Research Service has developed their 5 year plan. The objectives that they established are: (1) Obtain information on the field efficacy of alternative structural treatments, such as sulfuryl fluoride or heat, compared with methyl bromide. (2) Evaluate the impact of some alternative tactics such as reduced-risk aerosol insecticides or targeted treatment with residual contact insecticides as part of an IPM or systems approach to eliminate the need for, or reduce the frequency of, fumigations or other structural treatments. (3) Develop improved monitoring tools and strategies to evaluate the need for and effectiveness of different management tactics to improve the implementation of an IPM program. (4) Develop models using the above information with which to determine optimal management strategies using methyl bromide alternatives.

IPM

Research is continuing in the area of contour mapping to support pest management /IPM (Arbogast, et al. 2005; Nansen, et al., 2006). Spatial studies are important in monitoring pest populations. Contour mapping in Indian meal moth illustrate that higher trap catches are nearer the source of infestations (Arbogast, et al., 2005).

Efficient insect detection of cereal grains is being studied (Neethirajan, et al., 2007). Researchers are trying to develop efficient and fast insect detection techniques for grain. The potential of acoustic detection, carbon dioxide measurement, near-infrared spectroscopy, and soft X-ray methods have been discussed. Most were found to be cost prohibitive, and also the complexities of caibrating & operating the instruments presented problems to implementation (Neethirajan, et al., 2006).

The literature regarding essential oils consists of studies in small areas and laboratory experiments. In addition, none have included economic analyses. Thus these data do not shed light on commercial feasibility as yet. But numerous articles on essential oils have been published recently (Lee 2002; Nansen and Phillips, 2003) and on other spot-treatments (Lee, et al., 2003; Leelaja, et al. In Press; Wang, et al., 2006).

Hydroprene is receiving attention as well (Mohandass, et al. 2006a, 2006b). A review of hydroprene, an insect growth regulator, demonstrates that it works well on the immature stages of many of the stored product insects, but the efficacy depends upon the surface texture, temperature, and sanitation (Mohandass, et al. 2006a). In addition, mortality of Indian meal moth larvae is increased at higher temperatures Mohandass, et al., 2006b).

Alternative Fumigants

Phosphine investigations continue. Collins, et al. (2005) conducted laboratory studies examining resistant and susceptible strains of the *Rhyzopertha dominica* to a range of phosphine concentrations and exposure periods. Collins, et al. (2005) in studies on *R. dominica*, indicate that complete control can be expected in 5, 10, and 14 days depending on phosphine concentration. However, phosphine is corrosive to metal fixtures (as has been previously discussed).

Germinara, et al. (In Press) have begun preliminary investigations into the biological activity of proprionic acid on adults of *Sitophilus granarius* and *S. oryzae*. These laboratory studies demonstrated that proprionic acid was effective in killing adult weevils, and dose-dependent repellent effects.

Ozone as a fumigant in grain bins is being investigated (Kells, et al., 2001). Kells, et al. (2001) determined that ozone can be used as a fumigant in grain bins. In 8.9 tonnes of maize, with 50 ppm ozone for 3 days resulted in 92-100% mortality of adult red flour beetle, adult maize weevil and Indian meal moth larvae.

The registrant of sulfuryl fluoride is conducting more experiments through-out the U.S., but the results of the experiments are not available at the time of this nomination.

Heat Treatments

Boina and Subramanyam (2004) studied confused flour beetle life stages in the laboratory to a range of elevated temperatures. Boina and Subramanyam (2004) found that old larvae of confused flour beetles most resistant to elevated temperatures. In pupae & adults of red flour beetles, sublethal heat exposure resulted in impaired reproductive performance (Mahroof, et al. 2005).

New Grants

Kansas State University has received $369,181 in a USDA/CSREES grant to investigate aerosols as an alternative to methyl bromide in commercial flour mills, processing plants and food storage facilities (to be completed in 2009). Kansas State University had received a grant for optimizing heat treatments in these same facilities. Researchers at Purdue University have gotten funding from USDA/CSREES to develop a structural fumigation and analysis tool for sulfuryl fluoride and the combination of phosphine+heat+carbon dioxide. These and other CSREES Funded Projects can be found at: http://www.csrees.usda.gov/fo/fundview.cfm?fonum=1107.

(ii) OUTCOMES OF TRIALS: (*Include any available data on outcomes from trials that are still underway. Where applicable, complete the table included at Appendix I identifying comparative disease ratings and yields with the use of methyl bromide formulations and alternatives.*)

See 6(i) above.

(iii) IMPACT ON CRITICAL USE NOMINATION/REQUIRED QUANTITIES: *(For example, provide advice on any reductions to the required quantity resulting from successful results of trials.)*

The economic study that compared methyl bromide and sulfuryl fluoride fumigations has determined that sulfuryl fluoride in cocoa beans is both technically and economically feasible (Adam 2007). Therefore, cocoa beans are not included in the 2010 US CUN nomination.

The research discussed above (6i) demonstrates the effectiveness of sulfuryl fluoride against many pests. Only one study examined the economics of fumigation, and it found that sulfuryl fluoride is not yet economically feasible in food processing facilities (Adam 2007). However, this industry is learning how to implement sulfuryl fluoride as well as heat. There have been a few instances in the past of building damage from heat fumigations, as many heat companies are trying to match the down times of methyl bromide fumigations. This industry is also improving sanitation and other IPM techniques to reduce the number of fumigations in structures.

The USG has applied an aggressive transition rate which is reflected in the nomination amount and detailed in Appendix A.

During the preparation of this nomination the USG has accounted for all identifiable means to reduce the request. Specifically, approximately 13 million kilograms of methyl bromide were requested by methyl bromide users across all sectors. USG carefully scrutinized requests and made subtractions to ensure that no growth, double counting, inappropriate use rates on a treated hectare basis was incorporated into the final request. Use when the requestor qualified under some other provision (QPS, for example) was also removed and appropriate transition given yields obtained by alternatives and the associated cost differentials, was factored in. As a result of all these changes, the USG is requesting roughly 1/3 of that amount.

Therefore, other than the elimination of cocoa beans from its nomination, USG feels that no additional reduction in methyl bromide quantities is necessary, given the significant adjustments described above.

(iv) ACTIONS TO ADDRESS ANY DELAYS/OBSTACLES IN CONDUCTING OR FINALISING TRIALS:

Research takes both time and financial resources. The above experiments are continuing and require more time in order to complete. After the data are analyzed, the results will dictate what further actions will be needed. Any further investigations will need appropriate funding, most likely through competitive grants.

The USG has the ability to authorize Experimental Use Permits (EUPs) for large scale field trials for methyl bromide alternatives. As with other activities connected with registration of a pesticide, the USG has no legal authority either to compel a registrant to seek an EUP or to require growers to participate.

As noted in our previous nomination, the USG provides a great deal of funding and other support for agricultural research, and in particular, for research into alternatives for methyl bromide. This support takes the form of direct research conducted by the Agricultural Research Service (ARS) of USDA, through grants by ARS and CSREES, by IR-4, the national USDA-funded project that facilitates research needed to support registration of pesticides for specialty crop vegetables, fruits and ornamentals, through funding of conferences such as MBAO, and through the land grant university system. The 5-year accomplishments of this program are available at: http://www.ars.usda.gov/SP2UserFiles/Program/308/NP308AccomplishmentReport.pdf

7. TECHNOLOGY TRANSFER, SCALE-UP, REGULATORY APPROVAL FOR ALTERNATIVES

(i) DESCRIPTION AND IMPLEMENTATION STATUS:

The USDA maintains an extensive technology transfer system, the Agricultural Extension Service. This Service is comprised of researchers at land grant universities, county extension agents, and private pest management consultants. In addition to these sources of assistance for technology transfer, there are trade organizations and grower groups, some of which are purely voluntary but most with some element of institutional compulsion, that exist to conduct research, provide marketing assistance, and to disseminate “best practices.”

Many of the USDA grants include technology transfer. Most of the recipients of grants typically accomplish this by extension education (publications, websites) and industry engagement via trade-shows and conferences. Several awardees will hold hands-on training and demonstrations.

(ii) OUTCOMES ACHIEVED TO DATE FROM TECHNOLOGY TRANSFER, SCALE-UP, REGULATORY APPROVAL:

See above.

(iii) IMPACT ON CRITICAL USE NOMINATION/REQUIRED QUANTITIES: (*For example, provide advice on any reductions to the required quantity resulting from successful progress in technology transfer, scale-up, and/or regulatory approval.*)

The USG has applied an aggressive transition rate which is reflected in the nomination amount and detailed in Appendix A.

During the preparation of this nomination the USG has accounted for all identifiable means to reduce the request. Specifically, approximately 13 million kilograms of methyl bromide were requested by methyl bromide users across all sectors. USG carefully scrutinized requests and made subtractions to ensure that no growth, double counting, inappropriate use rates on a treated hectare basis was incorporated into the final request. Use when the requestor qualified under some other provision (QPS, for example) was also removed and appropriate transition given yields obtained by alternatives and the associated cost differentials, was factored in. As a result of all these changes, the USG is requesting roughly 1/3 of that amount.

The USG feels that no additional reduction in methyl is necessary.

(iv) ACTIONS TO ADDRESS ANY DELAYS/OBSTACLES:

Research takes both time and financial resources. The above experiments are continuing and require more time in order to complete. After the data are analyzed, the results will dictate what further actions will be needed. Any further investigations will need appropriate funding, most likely through competitive grants.

The USG has the ability to authorize Experimental Use Permits (EUPs) for large scale field trials for methyl bromide alternatives. As with other activities connected with registration of a pesticide, the USG has no legal authority either to compel a registrant to seek an EUP or to require growers to participate.

As noted in our previous nomination, the USG provides a great deal of funding and other support for agricultural research, and in particular, for research into alternatives for methyl bromide. This support takes the form of direct research conducted by the Agricultural Research Service (ARS) of USDA, through grants by ARS and CSREES, by IR-4, the national USDA-funded project that facilitates research needed to support registration of pesticides for specialty crop vegetables, fruits and ornamentals, through funding of conferences such as MBAO, and through the land grant university system. The 5-year accomplishments of this program are available at: http://www.ars.usda.gov/SP2UserFiles/Program/308/NP308AccomplishmentReport.pdf

8. COMMERCIAL SCALE-UP/DEPLOYMENT, MARKET PENETRATION OF ALTERNATIVES

(i) DESCRIPTION AND IMPLEMENTATION STATUS:

These issues are discussed in the National Management plan for methyl bromide submitted previously.

(ii) IMPACT ON CRITICAL USE NOMINATION/REQUIRED QUANTITIES: (*For example, provide advice on any reductions to the required quantity resulting from successful commercial scale-up/deployment and/or market penetration*.

The USG feels that no additional reduction in methyl bromide quantities is necessary

(iii) ACTIONS TO ADDRESS ANY DELAYS/OBSTACLES:

USG has no legal authority to compel registrations; it can only act on registrations requested by private entities. The timely submission of data to support a registration decision is at the sole discretion of the registrant.

The USDA maintains an extensive technology transfer system, the Agricultural Extension Service. This Service is comprised of researchers at land grant universities and county extension agents in addition to private pest management consultants. In addition to these sources of assistance for technology transfer, there are trade organizations and user groups, some of which are purely voluntary but most with some element of institutional compulsion, that exist to conduct research, provide marketing assistance, and to disseminate "best practices".

9. CHANGES TO TRANSITION PROGRAM

If the transition program outlined in the Party's original nomination has been changed, provide information on the nature of those changes and the reasons for them. Where the changes are significant, attach a full description of the revised transition program.

See Appendix A.

10. OTHER BROADER TRANSITION ACTIVITIES

Provide information in this section on any other transitional activities that are not addressed elsewhere. This section provides a nominating Party with the opportunity to report, where applicable, on any additional activities which it may have undertaken to encourage a transition, but need not be restricted to the circumstances and activities of the individual nomination. Without prescribing specific activities that a nominating Party should address, and noting that individual Parties are best placed to identify the most appropriate approach to achieve a swift transition in their own circumstances, such activities could include market incentives, financial support to exemption holders, labelling, product prohibitions, public awareness and information campaigns, etc.

These issues are discussed in the National Management plan for methyl bromide submitted previously.

PART D: REGISTRATION OF ALTERNATIVES

11. PROGRESS IN REGISTRATION

Where the original nomination identified that an alternative's registration was pending, but it was anticipated that one would be subsequently registered, provide information on progress with its registration. Where applicable, include any efforts by the Party to "fast track" or otherwise assist the registration of the alternative.

The registration status of the alternatives to methyl bromide has not changed since the previous nomination.

Methyl bromide alternatives do have a fast track for registration in the U.S. EPA. However, before registering a new pesticide or *new use* for a registered pesticide, EPA must first ensure that the pesticide, when used according to label directions, can be used with a reasonable certainty of no harm to human health and without posing unreasonable risks to the environment. To make such determinations, EPA requires more than 100 different scientific studies and tests from applicants. Where pesticides may be used on food or feed crops, EPA also sets tolerances (maximum pesticide residue levels) for the amount of the pesticide that can legally remain in or on foods.

There is a registration decision expected soon on applying an insect growth regulator, methoprene, onto a plastic film used for coating food boxes to control pests after food has been processed. It is undergoing review within the EPA Office of Pesticide Programs.

USG has no legal authority to compel registrations; it can only act on registrations requested by private entities. The timely submission of data to support a registration decision is at the sole discretion of the registrant. Please see table above for additional detail.

12. DELAYS IN REGISTRATION

Where significant delays or obstacles have been encountered to the anticipated registration of an alternative, the exemption holder should identify the scope for any new/alternative efforts that could be undertaken to maintain the momentum of transition efforts, and identify a time frame for undertaking such efforts.

Methyl bromide alternatives have a fast track for registration in the U.S. EPA. However, before registering a new pesticide or *new use* for a registered pesticide, EPA must first ensure that the pesticide, when used according to label directions, can be used with a reasonable certainty of no harm to human health and without posing unreasonable risks to the environment. To make such determinations, EPA requires more than 100 different scientific studies and tests from applicants. Where pesticides may be used on food or feed crops, EPA also sets tolerances (maximum pesticide residue levels) for the amount of the pesticide that can legally remain in or on foods.

13. DEREGISTRATION OF ALTERNATIVES

Describe new regulatory constraints that limit the availability of alternatives. For example, changes in buffer zones, new township caps, new safety requirements (affecting costs and feasibility), and new environmental restrictions such as to protect ground water or other natural *resources. Where a potential alternative identified in the original nomination's transition plan has subsequently been deregistered, the nominating Party would report the deregistration, including reasons for it. The nominating Party would also report on the deregistration's impact (if any) on the exemption holder's transition plan and on the proposed new or alternative efforts that will be undertaken by the exemption holder to maintain the momentum of transition efforts.*

No chemicals have been de-registered. However, methyl bromide use on structures, commodities, and post harvest treatments was reregistered in the US last year. The proposed mitigations for that reregistration include a fumigation management plan, treatment buffers to enhance worker safety and ventilation buffers to enhance bystander safety. The proposed buffers are based primarily on use rate, total amount of methyl bromide used, and the type and duration of aeration. The Reregistration Eligibility Decision for methyl bromide post harvest uses is available at: http://www.epa.gov/oppsrrd1/REDs/methyl_bromide_tred.pdf .

An additional complication in forecasting changes in the registration of alternatives is that under the US federal system individual states may impose restrictions above those imposed at the Federal level. Examples of these additional restrictions may include increasing buffer zones around facilities and chambers and requiring capture and destruction technology.

PART E: IMPLEMENTATION OF MBTOC/TEAP RECOMMENDATIONS

The Methyl Bromide Technical Options Committee and the Technology and Economic Assessment Panel may recommended that a Party explore and, where appropriate, implement alternative systems for deployment of alternatives or reduction of methyl bromide emissions.

Where the exemptions granted by a previous Meeting of the Parties included conditions (for example, where the Parties approved a reduced quantity for a nomination), the exemption holder should report on progress in exploring or implementing recommendations.

Information on any trialling or other exploration of particular alternatives identified in TEAP recommendations should be addressed in Part C.

14. USE/EMISSION MINIMISATION MEASURES

Where a condition requested the testing of an alternative or adoption of an emission or use minimisation measure, information is needed on the status of efforts to implement the recommendation. Information should also be provided on any resultant decrease in the exemption quantity arising if the recommendations have been successfully implemented. Information is required on what actions are being, or will be, undertaken to address any delays or obstacles that have prevented implementation.

During the preparation of this nomination the USG has accounted for all identifiable means to reduce the request. Specifically, approximately 13 million kilograms of methyl bromide were requested by methyl bromide users across all sectors. USG carefully scrutinized requests and made subtractions to ensure that no growth, double counting, inappropriate use rates on a volume basis was incorporated into the final request. Use when the requestor qualified under some other provision (QPS, for example) was also removed and appropriate transition given yields obtained by alternatives and the associated cost differentials~~,~~ was factored in. As a result of all these changes, the USG is requesting roughly 1/3 of that amount.

The USG feels that no additional reduction in methyl bromide quantities is necessary, given the significant adjustments described above.

PART F: ECONOMIC ASSESSMENT

15. ECONOMIC INFEASIBILITY OF ALTERNATIVES – Methodology *(MBTOC will assess economic infeasibility based on the methodology submitted by the nominating Party. Partial budget analysis showing the operations' gross and net returns for methyl bromide and next best alternatives is a widely accepted approach. Analyses should be supported by discussions identifying which costs and revenues change and why. The following measures may be useful descriptors of the economic outcome using methyl bromide or alternatives. Parties may identify additional measures. Regardless of the methodology used, this section should explain why the calculated measures with the alternative are levels that indicate the alternative is not economically feasible. In the case of culturally significant artifacts economic assessment may not be practical.):*

The following measures or indicators may be used as a guide for providing such a description:

(a) The purchase cost per kilogram of methyl bromide and of the alternative;
(b) Gross and net revenue with and without methyl bromide, and with the next best alternative;
(c) Percentage change in gross revenues if alternatives are used;
(d) Losses per cubic meter relative to methyl bromide if alternatives are used;
(e) Losses per kilogram of methyl bromide requested if alternatives are used;
(f) Losses as a percentage of net cash revenue if alternatives are used;
(g) Percentage change in profit margin if alternatives are used.

TABLE F 1. SUMMARY OF ECONOMIC REASONS FOR EACH ALTERNATIVE NOT BEING FEASIBLE OR AVAILABLE

No.	Methyl Bromide Alternative	Economic Reason (if any) for the Alternative not Being Available	Estimated Month/Year when the Economic Constraint could be Solved
1	Heat Treatment	Under laboratory conditions, brief exposure of commodities to high temperatures may eliminate insects without adversely affecting product quality. Sufficiently high temperature will kill insects given enough time; but heat sources are not readily available in all areas of United States (such as those in the south where hot weather is the norm and no heaters are available); and heat requires longer time of exposure. In areas that can use heat, it is being used. It is not feasible in remaining plants or areas of a plant. Also, this approach is not feasible for treating commercial-scale commodity volumes, as heat is a poor penetrator of packaging, boxes, and commodities. Most insects do not survive more than 12 hours when exposed to 45^{o}C or more than 5 minutes when exposed to 50^{o}C (Fields, 1992). However, the effectiveness of this approach has not been tested with large volumes of commodities.	No indication was given by the applicant as to a timetable to solve identified problems.

		Substitution of heat treatments where high temperatures are not already used for other applications would require extensive retrofitting of existing facilities, as well as heat delivery systems capable of rapidly and uniformly heating large volumes of commodities in order to achieve total insect control. Furthermore, cheese quality may be adversely affected by exposure to heat.	
2	Phosphine alone or in combination	Although does kill insects, it is corrosive to metals, especially copper and its alloys, bronze and brass. These metals are important components of the electronics that run the manufacturing equipment. In addition some of the equipment itself (for example: motors, mixers, etc.) also have metal parts that contain copper. In addition it requires longer application time. This alternative is already being used in the areas without electronics and where temperatures are not a factor. Resistance to this fumigant has also been reported for several stored product pests. Also, not suitable to replace methyl bromide when rapid fumigations are needed to meet customer timelines. Furthermore, cheese makers claim that phosphine causes damage to the cheese, "melting of the cheese" and may cause acid residue, acrid off-odors and affect flavor. Phosphine fumigation takes 3-10 days, depending on temperature, compared to 1 day for MB (Hartsell et al., 1991, Zettler, 2002, Soderstrom et al., 1984, phosphine labels). An additional 2 days are needed for outgassing phosphine. Phosphine fumigation is least feasible during the colder winter months when, according to label directions, the minimum exposure periods increases to 8-10 days (plus two days for aeration) when commodity temperature decreases to $5^{o}C$ - 12 ^{o}C. Phosphine is not used when commodity temperature drops below $5^{o}C$ (Phosphine and Eco2fume® labels).	No indication was given by the applicant as to a timetable to solve identified problems.
3	Irradiation	Although rapid and effective, irradiation may result in living insect left in the treated product. Treated insects are sterilized and stop feeding, but are not immediately killed. The high dosages necessary to cause immediate mortality in target insects may reduce product quality. Irradiation requires major capital expenditures and irradiated food are not widely accepted by consumers.	No indication was given by the applicant as to a timetable to solve identified problems.
4	Carbon Dioxide (high pressure)	Facilities in the United States are not airtight enough for modified atmospheres or carbon dioxide to be effective primarily because most are more than 25 years old.	No indication was given by the applicant as to a timetable to solve identified problems.
5	Sulfuryl Fluoride	Federal Registration very recent: July 14, 2005; not enough information available by applicant to assess. For food-processing facilities where sulfuryl	

		fluoride is technically feasible, it costs four to five times as much as methyl bromide for similar results.	

Commodities and food-processing facilities listed in this chapter were requested by the National Pest Management Association which represents members that provide fumigation services to food processing and storage facilities. The economic impacts on the facility from using the next best alternative could not be assessed since the applicant is not the end-user. However, the uses included in this chapter are those with no technically and economically feasible alternative. In general, economic impacts to the commodity and food processing sector can be characterized as arising from three contributing factors. First, the direct pest control costs increased in most cases because phosphine is more expensive due to increased labor time required for longer treatment time and increased number of treatments. Second, capital expenditures may be required to adopt phosphine for accelerated replacement of plant and equipment due to corrosive nature of phosphine. Finally, additional production downtimes for the use of alternatives are unavoidable. Many facilities operate at or near full production capacity and alternatives that take longer than methyl bromide or require more frequent application can result in manufacturing slowdowns, shutdowns, and shipping delays. Slowing down production would result in additional costs to the methyl bromide users.

The industries that use methyl bromide for commodity and facility fumigation are, in general, subject to limited pricing power, changing market conditions, and government regulations. Companies within these industries operate in a highly competitive global marketplace characterized by high sales volume, low profit margins, and rapid turnover of inventories. In addition, producers' associations generally manage companies of this type, and, therefore, making new capital investment is often difficult.

Measures of Economic Impacts of Methyl Bromide Alternatives

For commodities listed in this chapter, an economic analysis was not conducted because this sector did not have an alternative registered. For food-processing facilities listed in this chapter, annual costs of alternatives were compared to methyl bromide (Table 14.2). However, economic feasibility of such alternatives was not assessed due to the lack of revenue information which is necessary to quantify the economic impacts to food-processing facilities.

TABLE F.2: ANNUAL COSTS OF ALTERNATIVES COMPARED TO METHYL BROMIDE*

	Methyl Bromide	Sulfuryl Fluoride	Heat Treatment
Annual Cost per 1,000 M^3	$420	$2,100	$804

*Costs in this table only include the cost of fumigation or heat treatment.
*Estimates of the cost of sulfuryl fluoride are based on information provided by the applicant that it is necessary to use sulfuryl fluoride at a rate, which costs up to five times as much as methyl bromide for similar results.

PART G: CHANGES TO QUANTITY OF METHYL BROMIDE REQUESTED

This section seeks information on any changes to the Party's requested exemption quantity.

16. CHANGES IN USAGE REQUIREMENTS

Provide information on the nature of changes in usage requirements, including whether it is a change in dosage rates, the number of hectares or cubic metres to which the methyl bromide is to be applied, and/or any other relevant factors causing the changes.

The USG has applied an aggressive transition rate which is reflected in the nomination amount and detailed in Appendix A.

During the preparation of this nomination the USG has accounted for all identifiable means to reduce the request. Specifically, approximately 13 million kilograms of methyl bromide were requested by methyl bromide users across all sectors. USG carefully scrutinized requests and made subtractions to ensure that no growth, double counting, inappropriate use rates on a treated hectare basis was incorporated into the final request. Use when the requestor qualified under some other provision (QPS, for example) was also removed and appropriate transition given yields obtained by alternatives and the associated cost differentials~~,~~ was factored in. As a result of all these changes, the USG is requesting roughly 1/3 of that amount.

The USG feels that no additional reduction in methyl is necessary.

17. RESULTANT CHANGES TO REQUESTED EXEMPTION QUANTITIES

TABLE G 1. RESULTANT CHANGES TO REQUESTED EXEMPTION QUANTITIES

QUANTITY REQUESTED FOR PREVIOUS NOMINATION YEAR:	**66,777 kgs**
QUANTITY APPROVED BY PARTIES FOR PREVIOUS NOMINATION YEAR:	**54,606 kgs**
QUANTITY REQUIRED FOR YEAR TO WHICH THIS REAPPLICATION REFERS:	**37,778 kgs**

PART H: CITATIONS

Adam, Brian D. 2007. Cost comparison of methyl bromide and ProFume® for fumigating a food processing facility: a report to National Pest Management Association and Dow AgroSciences. Working paper #AEP-0704, Oklahoma State University, Dept. of Agricultural Economics, 2007. Available at http://agecon.okstate.edu/faculty/publications_results.asp?page=1.

Arbogast, R. T., Shahpar, R Chini, J. E. Mcgovern. 2005. Plodia interpunctella (Lepidoptera:Pyralidae): spatial relationship between trap catch and distance from a source of emerging adults. J Econ. Entomol. 98(2):326-333.

Arthur, F. H. 2000. Toxicity of diatomaceous earth to red flour beetles and confused flour beetles (Coleoptera: Tenebrionidae): Effects of temperature and relative humidity. J. Econ. Entomol. 93(2): 526-532.

Arthur, F. H. 1992. Cyfluthrin WP and EC formulations to control malathion-resistant red flour beetles and confused flour beetles (Coleoptera: Tenebrionidae): Effects of paint on residual activity. J. Entomol. Sci. 27(4):436-444.

Arthur, F. and T. W. Phillips. 2003. Stored-product insect pest management an d control, In: Food Plant Sanitation eds: Y. H. Hui, B. L. Bruinsma, J. R. Gorham, W. Nip, P. S. Tong, and P. Ventresca. Marcel Dekker, Inc., New York, pp. 341-358.

Bell, C. H. 2000. Fumigation in the 21st century. Crop Protection 19:563-569.

Boina, D. and B. Subramanyam. 2004. Relative susceptibility of Tribolium confusum life stages exposed to elevated temperatures. J. Econ. Entomol. 97(6):2168-2173.

Collins, P. J., G. J. Daglish, H. Pavic and R. A. Kopittke. 2005. Response of mixed-age cultures of phosphine-resistant and susceptible strains of lesser grain borer, Rhyzopertha dominica, to phosphine at a range of concentrations and exposure periods. J Stored Products Research 41(4): 373-385.

Cox, P.D. 2004. Potential for using semiochemicals to protect stored products from insect infestation. J Stored Prod. Res. 40:1-25.

Dowdy, A K.& P. G. Fields. 2002. Heat combined with diatomaceous earth to control the confused flour beetle (Coleoptera: Tenebrionidae) in a flour mill. J Stored Prod. Res. 38:11-22.

Dunkel, F. V. and L. J. Sears. 1998. Fumigant properties of physical preparations from Mountain big sagebrush, Artemisia tridentate Nutt. ssp. vaseyana (Rydb.) Beetle for stored grain insects. J. Stored Prod. Res. 34(4):307-321.

Fields, P. and N. D. G. White. 2002. Alternatives to methyl bromide treatments for stored-product and quarantine insects. Annual Review of Entomology 47:331-59.

Germinara, G. S., G. Rotundo, and A. De Cristofaro. In Press. Repellence and fumigant toxicity of propionic acid against adults of Sitophilus granarius (L.) and S. oryzae (L.). J Stored Products Research available online August 2006.

Hou, X., P. Fields, and W. Taylor. 2004. The effect of repellents on penetration into packaging by stored-product insects. J Stored Prod. Res. 40:47-54.

Kells, S. A., L. J. Mason, D. E. Maier, and C. P. Woloshuk. 2001. Efficacy and fumigation characteristics of ozone in stored maize. J Stored Products Research 37(4): 371-382.

Lee, Sung-Eun. 2002. Biochemical mechanisms conferring cross-resistance to fumigant toxicities of essential oils in a chlorpyrifos-methyl resistant strain of Oryzaephilus surinamensis L. (Coleoptera:Silvanidae). J Stored Products Research 38(2): 157-166.

Lee, S., C. J. Peterson, and J.R. Coats. 2003. Fumigation toxicity of monoterpenoids to several stored product insects. J Stored Products Research 39(1): 77-85.

Leelaja, B. C., Y. Rajashekar, P. V. Reddy, K. Begum, and S. Rajendran. In Press. Enhanced fumigant toxicity of allyl acetate to stored-product beetles in the presence of carbon dioxide. J Stored Products Research available online January 2006.

Mahroof, R., B. Subramanyam, and P. Flinn. 2005. Reproductive performance of Tribolium castaneum (Coleoptera: Tenebrionidae) exposed to minimum heat treatment temperature as pupae and adults. J. Econ. Entomol. 98(2):626-633.

Mahroof, R., Subramanyam, B. and Eustace, D. 2003. Temperature and relative humidity profiles during heat treatment of mills and its efficacy against Tribolium castaneum (Herbst) life stages. J. Stored Prod. Res. 39:555-569.

Mahroof, R., B. Subramanyam, J. E. Throne, and A. Menon. 2003. Time-mortality relationships for Tribolium castaneum (Coleoptera: Tenebrionidae) life stages exposed to elevated temperatures. J. Econ. Entomol. 96(4): 1345-1351.

Mohandass, S., F. H. Arthur, K. Y. Zhu, and J. E. Throne. 2006a. Hydroprene prolongs developmental time and increases mortality in wandering-phase Indianmeal moth (Lepidoptera:Pyralidae)larvae. J. Econ. Entomol. 99(4):1509-1519.

Mohandass, S. M., F. H. Arthur, K. Y. Zhu, and J. E. Throne. 2006b. Hydroprene: mode of action, current status in stored-product pest management, insect resistance, and future prospects. Crop Protection 25:902-909.

Mueller, D. K. 2002. Insect resistance testing. Fumigants and Pheromones 62:1-2.

Nansen, C., T. W. Phillips, P. K. Morton, and E. J. Bonjour. 2006. Spatial analysis of pheromone-baited trap captures form controlled releases of male Indianmeal moths. Environ. Entomol. 35(2):516-523.

Nansen, C. and T. W. Phillips. 2003. Ovipositional responses of the Indianmeal moth, Plodia interpunctella (Hubner) (Lepidoptera:Pyralidae) to oils. Annals Entomol. Soc. Amer. 96(4):524-531.

Neethirajan, S., C. Karunakaran, D. S. Jayas, and N. D. G. White. 2007. Detection techniques for stored-product insects in grain. Food Control 18(2):157-162.

Nielsen, P. S. 1998. The effect of a diatomaceous earth formulation on the larvae of Ephestia kuehniella Zeller. J Stored Prod. Res 34:113-121.

Oberlander, H., D. L. Silhacek, E. Shaaya, and I. Ishaaya. 1997. Current status and future perspectives of the use of insect growth regulators for the control of stored product insects. J Stored Prod. Res. 33:1-6.

Skovgard, H., N. Holst, and P. S. Nielsen. 1999. Simulation model of the Mediterranean flour moth (Lepidoptera: Pyralidae) in Danish flour mills. Environ. Entomol. 28(6):1060-1066.

Taylor, R.W.D. 1989. Phosphine, a major grain fumigant at risk. Int. Pest Control. 31:10-14.

Wang, J., F. Zhu, X. M. Zhou, C. Y. Niu, and C. L. Lei. 2006. Repellent and fumigant activity of essential oil from Artemisia vulgaris to Tribolium castaneum (Herbst) (Coleoptera: Tenebrionidae). J Stored Products Research 42(3): 339-347.

Zettler, J. L. 1991. Pesticide resistance in Tribolium castaneum and T. confusum (Coleoptera: Tenebrionidae) form flour mills in the United States. J. Econ. Entomol. 84(3):763-767.

Zettler, J. L. and F. H. Arthur. 2000. Chemical control of stored product insects with fumigants and residual treatments. Crop Protection 19:577-582.

APPENDIX A 2010 METHYL BROMIDE USAGE NEWER NUMERICAL INDEX EXTRACTED (BUNNIE)

2010 Methyl Bromide Usage Newer Numerical Index - BUNNIE **NPMA**

January 16, 2008	Region		Processed Foods	Spices and Herbs	Cocoa	Cheese Processing Plants	Sector Total	Notes
Dichotomous Variables	Currently Use Alternatives?		Yes	Yes		Yes		
	Pest-free Requirements?		Yes	Yes		Yes		
Other Issues	Frequency of Treatment of Product		1x per year	1x per year		1x per year		
	Quarantine & Pre-Shipment Removed?		Yes	Yes		Yes		
Most Likely Combined Impacts (%)	Regulatory Issues (%)		0%	0%		0%		
	Key Pest Distribution (%)		100%	100%		100%		
	Total Combined Impacts (%)		**100%**	**100%**		**100%**		
Most Likely Baseline Transition	(%) Able to Transition		84%	84%	***Nomination Withdrawn as of June 29, 2007***	0%		
	Minimum # of Years Required		4	4		4		
	(%) Able to Transition per Year		**21%**	**21%**		**0%**		
EPA Adjusted Use Rate (kg/1000m3)			**20**	**20**		**20**		
2010 Applicant Requested Usage	*Amount - Pounds*	*Pounds*	*200,000*	*20,000*		*4,000*	*224,000*	
	Volume - 1000ft^3		*160,000*	*16,000*		*3,200*	*179,200*	
	Rate (lb/1000ft^3)		*1.25*	*1.25*		*1.25*	*1.25*	
	Amount - Kilograms	Metric	**90,718**	**9,072**		**1,814**	**101,605**	
	Volume - 1000m^3		4,531	453		91	5,074	
	Rate (kg/1000m^3)		20	20		20	20	
EPA Preliminary Value		**kgs**	**90,718**	**9,072**		**1,814**	**101,605**	
EPA Baseline Adjusted Value has been adjusted for:			MBTOC Adjustments, QPS, Double Counting, Growth, Use Rate, Miscellaneous Adjustments, and Combined Impacts					
EPA Baseline Adjusted Value		kgs	90,614	6,591	***Nomination Withdrawn as of June 29, 2007***	1,812	99,018	
EPA Transition Amount		kgs	(57,087)	(4,153)		-	(61,239)	
EPA Amount of All Adjustments		**kgs**	**(57,191)**	**(6,633)**		**(2)**	**(63,826)**	
Most Likely Impact Value (kgs)		kgs	**33,527**	**2,439**		**1,812**	**37,778**	
		1000m^3	**1,676**	**122**		**91**	**1,889**	
		Rate	**20**	**20**		**20**	**20**	
Sector Research Amount (kgs)			**-**	**2010 Total US Sector Nomination**		**37,778**		

1 Pound = 0.453592 kgs 1000 cubic feet= 0.028316847 1000 cubic meters

1 lb/1000 ft^3 = 0.0624 kg/1000 m^3 (ounces/1000 ft^3 ~ kg/1000 m^3)